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Illnesses and Injuries Related to Total Release Foggers --- Eight States, 2001--2006

Total release foggers (TRFs), sometimes called "bug bombs," are pesticide products designed to fill an area with insecticide and often are used in homes and workplaces to kill cockroaches, fleas, and flying insects. Most TRFs contain pyrethroid, pyrethrin, or both as active ingredients. TRFs also contain flammable aerosol propellants that can cause fires or explosions. The magnitude and range of acute health problems associated with TRF usage has not been described previously. This report summarizes illnesses and injuries that were associated with exposures to TRFs during 2001--2006 in eight states (California, Florida, Louisiana, Michigan, New York, Oregon, Texas, and Washington) and were investigated by the California Department of Pesticide Regulation (CDPR) and state health departments participating in the SENSOR-Pesticides program.* During 2001--2006, a total of 466 TRF-related illnesses or injuries were identified. These illnesses or injuries often resulted from inability or failure to vacate before the TRF discharged, reentry into the treated space too soon after the TRF was discharged, excessive use of TRFs for the space being treated, and failure to notify others nearby. The findings indicate that TRFs pose a risk for acute, usually temporary health effects among users and bystanders. To reduce the risk for TRF-related health effects, integrated pest management control strategies that prevent pests' access to food, water, and shelter need to be promoted and adopted. In addition, awareness of the hazards and proper use of TRFs need to be better communicated on TRF labels and in public media campaigns.

States participating in the SENSOR-Pesticides program and CDPR conduct surveillance on pesticide poisoning. In addition, the New York City Department of Health and Mental Hygiene through the New York City Poison Control Center (NYCPCC) has access to data on pesticide poisoning. No other states or cities conduct pesticide poisoning surveillance. Cases of acute TRF-related illness or injury consistent with the national case definition for acute pesticide-related illness or injury

(1) ([Table 1](#)) and occurring during 2001--2006 (the latest years for which complete surveillance data were available) were provided to CDC by these surveillance programs. Cases of TRF-related illness or injury were classified by the state agencies as definite, probable, possible, or suspicious, according to pesticide exposure and health effects criteria ([Table 1](#)). CDC classified the cases provided by NYCPCC. Data from the state agencies and NYCPCC were compared, and duplicate cases were eliminated. In addition to receiving reports from poison control centers, each surveillance program obtains case reports from several other sources, principally state agencies with jurisdiction over pesticide use (e.g., departments of agriculture) and workers compensation claims (2,3). Some California cases might have been missed because the CDPR contract with the California Poison Control System to receive poisoning reports lapsed after 2002 and was not reestablished until late 2006. Detailed information was collected on each case, including demographic data, signs and symptoms, illness or injury severity,[†] Environmental Protection Agency (EPA) toxicity category,[§] identity of implicated pesticides, location of the exposure, and information on factors that might have contributed to the exposure. Three recent case reports are provided to illustrate common patterns observed in the surveillance data.

Case Reports

Case 1. In March 2008, a woman aged 38 years from Washington visited an emergency department with headache, shortness of breath, nausea, leg cramps, burning eyes, cough, and weakness after she was exposed to fumes from three TRFs (in 6-ounce cans) deployed nearly simultaneously by a downstairs apartment neighbor. One TRF each was set off in the crawlspace beneath the house, in the neighbor's apartment, and in the hallway. The building was an old house converted into apartments, with a single ventilation system connecting all apartments. The neighbor had orally notified some of the tenants but not the patient. The patient recovered completely within 3 days, and the illness was classified as low severity. The TRF dispensed a toxicity category III pesticide product that contained permethrin and tetramethrin as active ingredients.

Case 2. In September 2007, a man aged 34 years who worked as a maintenance worker at an apartment complex in Michigan forgot to disarm the smoke detector before activating a TRF. Because the building elevator shuts down if a smoke detector is triggered, the maintenance worker (without respiratory protection) reentered the mist-filled apartment to disarm the detector. He had onset of cough and upper airway irritation approximately 1 hour after exposure, contacted a poison control center, and did not seek additional medical care. His symptoms resolved within 24 hours, and his TRF-related illness was classified as low severity. He was exposed to a toxicity category III pesticide product with pyrethrins, cyfluthrin, and piperonyl butoxide as active ingredients.

Case 3. In August 2007, a man aged 54 years in California simultaneously set off nine TRFs in his small 700 square foot (6,000 cubic foot) home. Each 1.5-ounce TRF can was designed to treat 5,000 cubic feet of unobstructed space and released a toxicity category III pesticide product containing cypermethrin. When the man returned 6 hours later, a strong odor prompted him to open the doors and windows and to vacate. Entering a second time 4 hours later, the man had onset of headache, dizziness, nausea, and vomiting. He visited an emergency department, where he was treated symptomatically for TRF-related illness with a nebulized anticholinergic bronchodilator, intravenous hydration, and intravenous medication for headache, nausea, and bradycardia. He completely recovered after 36 hours, and his illness was classified as moderate severity.

Surveillance Data

A total of 466 cases of acute, pesticide-related illness or injury associated with exposure to TRFs during 2001--2006 were identified. SENSOR-Pesticides reported 368 cases, CDPR reported 40 cases, and NYCPCC reported 58 cases. Median age of affected persons was 35 years (range: 0--90 years); 255 (57%) were female, and 55 (13%) were exposed while at work. Race information was available for 137 patients, of whom 101 (74%) were white, 17 (12%) were black, and 19 (14%) were of other races. Ethnicity information was available for 158 patients, of whom 31 (20%) were Hispanic. Three cases occurred among pregnant women, and approximately 44 cases occurred among persons with asthma.

A total of 372 (80%) cases were classified as low severity, 84 (18%) cases were moderate severity, and nine (2%) were high severity. One death was classified by the Washington State Department of Health as suspicious. (This death occurred in a female infant aged 10 months who was put to bed the evening of the day her apartment was treated with three TRFs. The infant was found dead the next morning.) Twenty-one persons were hospitalized for 1 or more days (range: 1--35 days), and 43 persons lost time from work or other usual activities because of their illness or injury.

A total of 394 (85%) TRF exposures occurred in private residences ([Table 2](#)). Among the 388 cases for which information was available regarding who activated the TRF, 197 (51%) of the illnesses involved the person who activated the TRF.

Among the 463 cases for which information on the implicated TRF product was available, 449 (97%) occurred in persons who were exposed to products with pyrethrin, pyrethroid, or both as active ingredients ([Table 3](#)). Health effects most commonly involved the respiratory system (in 358 [77%] cases) ([Table 2](#)). The most common factors contributing to exposure included an inability or failure to vacate before the TRF discharged, early reentry, excessive use of TRFs for the space being treated, unintentional discharge of a TRF, and failure to notify others nearby ([Table 2](#)).

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Editorial Note:

TRFs are registered by EPA for use by home owners and others. When activated, the TRF cans are designed to empty their contents completely. No special training or licensing is required to use a TRF. Although numerous media reports in recent years have described injuries and property destruction resulting from explosions caused by activation of TRFs in the presence of ignition sources (e.g., gas pilot lights and electrical appliances, such as air conditioners and refrigerators, that cycle off and on) (D. Richmond, California Department of Pesticide Regulation, personal communication, 2008), this is the first report in the scientific literature to describe the range of exposure circumstances and acute health problems associated with TRF usage.

TRFs generally release pyrethroids, pyrethrins, or both. Pyrethrins are insecticides derived from chrysanthemum flowers (pyrethrum) (4). Piperonyl butoxide and n-octyl bicycloheptene dicarboximide often are added to pyrethrin products to inhibit insects' microsomal enzymes that detoxify pyrethrins (4). Although pyrethrins have little systemic toxicity in mammals, they appear to possess some irritant and sensitizing properties (4) and have been reported to induce contact dermatitis, conjunctivitis, and asthma (5,6). In addition, anaphylactic reactions (4) and health effects involving the neurologic, cardiovascular, and gastrointestinal systems have been reported (6). Pyrethroids are a class of synthetic insecticides that are chemically similar to natural pyrethrins (3) and have low potential for systemic toxicity in mammals. Signs and symptoms of pyrethroid toxicity include abnormal skin sensation (e.g., burning, itching, tingling, and numbness), dizziness, salivation, headache, fatigue, vomiting, diarrhea, seizure, irritability to sound and touch, and other central nervous system effects (4,7). Propellants and other solvents in the TRFs also might contribute to observed symptoms (4).

The findings in this report are subject to at least five limitations. First, the number of reported cases is probably an underestimate of the actual magnitude of illnesses and injuries associated with TRFs. The surveillance systems that identified cases are passive and, therefore, might have missed some TRF-related illnesses and injuries. Second, in 2006, only 10 states had pesticide poisoning surveillance systems, and the

data in this report might not be representative of the 40 states without such surveillance systems. Third, because most (85%) TRF-related case reports were obtained from poison control centers, some California cases might have been missed when the contract between CDPR and the California Poison Control System was not in effect. Fourth, TRF-related illnesses and injuries also might have been missed because exposure and health effects information was insufficient to satisfy the case definition in some instances (e.g., approximately 68 reports were excluded because information on TRF ingredients were not available, and approximately 100 NYCPCC reports were excluded because health effects data were missing or sparse). Finally, although all cases were consistent with case definition criteria, the possibility of false positives cannot be excluded. Because clinical findings of pesticide poisoning often are nonspecific and no standard diagnostic test exists, some illnesses related temporally to TRF exposures might be coincidental and not caused by TRFs.

TRFs can reduce pest populations and often are used by consumers as a low cost alternative to professional pest control services. However, because of their design to broadcast pesticides, they have a substantial potential for unintended exposures, especially when the pesticide label is ignored or misunderstood. Greater efforts are needed to promote safer alternatives to TRFs. Integrated pest management (IPM) control strategies need to be promoted and adopted. IPM can reduce indoor insect populations and minimize the need for insecticides (8).

The public also should be warned about TRF dangers through broad media campaigns that explain the importance of reading and understanding the pesticide label, using the correct number of TRFs, and taking necessary precautions (e.g., turning off ignition sources and promptly leaving the premises). TRF labels should be improved to make information easier to find and understand. Current TRF labels indicate the number of cubic feet that one container will treat effectively for pests, which requires the user to employ arithmetic to calculate both the volume of space to be treated and the number of TRFs needed to treat a space of that size. Use of delayed-release TRFs also might prevent illnesses and injuries by allowing the user to vacate the premises before the insecticide is released. Notices should be posted on the exterior of spaces where TRFs are used, indicating when the TRF treatment will be made and when reentry into the space is permitted. Coinhabitants (and nearby neighbors, when multiunit housing is treated) also should be informed at least 24 hours before a TRF treatment is started.

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* Under the Sentinel Event Notification System for Occupational Risk (SENSOR)-Pesticides program, CDC provides cooperative agreement funding and technical support to state health departments to conduct surveillance of acute, occupational, pesticide-related illness and injury. Funding support also is provided by the Environmental Protection Agency. Health departments in 10 states (Arizona, California, Florida, Louisiana, Michigan, New Mexico, New York, Oregon, Texas, and Washington) participated through 2006. Additional information is available at <http://www.cdc.gov/niosh/topics/pesticides>.

† Severity for SENSOR and CDPR cases was coded using standardized criteria (available at <http://www.cdc.gov/niosh/topics/pesticides>). Low-severity illnesses or injuries consist of illnesses and injuries that generally resolve without treatment and where minimal time (<3 days) is lost from work. Such cases typically manifest as eye, skin, and/or upper respiratory irritation. Moderate severity illnesses and injuries consist of non--life-threatening health effects that are generally systemic and require medical treatment. No residual disability is detected, and time lost from work is <6 days. High-severity illnesses and injuries consist of life-threatening health effects that usually require hospitalization, involve substantial time lost from work (>5 days), and can result in permanent impairment or disability. Deaths are fatalities resulting from exposure to one or more pesticides. NYCPCC uses similar criteria for coding severity.

§ EPA classifies pesticide products into one of four toxicity categories based on established criteria (40 CFR part 156). Pesticides with the greatest toxicity are in category I, and those with the least are in category IV.

Table 1

TABLE 1. Case definition matrix for total release fogger (TRF)-related illnesses or injuries — eight states,* 2001–2006

Classification criteria†	Classification category			
	Definite	Probable	Possible	Suspicious
Exposure	1	1 2	2	1 or 2
Health effects	1	2 1	2	1 or 2
Causal relationship	1	1 1	1	4

SOURCE: CDC. Case definition for acute pesticide-related illness and injury cases reportable to the National Public Health Surveillance System. Cincinnati, OH: US Department of Health and Human Services, CDC, National Institute for Occupational Safety and Health; 2005. Available at http://www.cdc.gov/niosh/topics/pesticides/pdfs/casedef2003_revapr2005.pdf.

* California, Florida, Louisiana, Michigan, New York, Oregon, Texas, and Washington.

† Cases are defined as definite, probable, possible, or suspicious based on scores for each of three criteria: exposure, health effects, and causal relationship. Scores may be 1, 2, or 4 and are assigned based on available evidence for each criterion. For example, a definite case has a score of 1,1,1 (i.e., a score of 1 on all three criteria), and a probable case may have a score of 1,2,1 or 2,1,1. Exposure scores: 1 = laboratory, clinical, or environmental evidence that corroborates TRF exposure; 2 = evidence of TRF exposure based solely on written or verbal report from the patient, a witness, or applicator. Name or chemical class of the active ingredients contained in the TRF is required (unless health effects are produced by an explosion). Health effects scores: 1 = two or more new postexposure signs or laboratory findings reported by a licensed health professional; 2 = two or more postexposure symptoms reported by the patient. Causal relationship scores: 1 = the known toxicology of the putative TRF was consistent with the observed health effects; 4 = insufficient toxicologic information was available to determine a causal relationship between the TRF exposure and the health effects.

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Table 2

TABLE 2. Number and percentage of total release fogger (TRF)-related illnesses or injuries, by data source* and selected characteristics — eight states,† 2001–2006

Characteristic	SENSOR (n = 368)	CDPR (n = 40)	NYCPCC (n = 58)	Total (N = 466)	
				No.	(%)
Severity of illness or injury[‡]					
High or death	5	2	3	10	(2)
Moderate	50	9	25	84	(18)
Low	313	29	30	372	(80)
Year of exposure					
2001	17	14	4	35	(8)
2002	37	12	2	51	(11)
2003	63	4	12	79	(17)
2004	73	2	27	102	(22)
2005	88	4	4	96	(21)
2006	90	4	9	103	(22)
Reporting state					
California	1	40	—	41	(9)
Florida	62	—	—	62	(13)
Louisiana	101	—	—	101	(22)
Michigan	20	—	—	20	(4)
New York	65	—	58	123	(26)
Oregon	29	—	—	29	(6)
Texas	32	—	—	32	(7)
Washington	58	—	—	58	(12)
Status[§]					
Definite	23	6	1	30	(6)
Probable	52	30	5	87	(19)
Possible	291	4	52	347	(75)
Suspicious	2	0	0	2	(<1)
Maximum toxicity^{**}					
I (Danger)	1	0	0	1	(<1)
II (Warning)	16	3	3	22	(5)
III (Caution)	289	37	36	362	(78)
Unknown/Missing	62	0	19	81	(17)
Location of exposure					
Private residence	306	32	56	394	(85)
Nonmanufacturing commercial	22	4	1	27	(6)
Other	16	4	1	21	(5)
Unknown	24	0	0	24	(5)

See Table 2 footnotes on next page.

TABLE 2. (Continued) Number and percentage of total release fogger (TRF)-related illnesses or injuries, by data source* and selected characteristics — eight states,† 2001–2006

Characteristic	SENSOR (n = 368)	CDPR (n = 40)	NYCPCC (n = 58)	Total (N = 466)	
				No.	(%)
Factors contributing to exposure††					
Unable to vacate before TRF discharged	79	6	22	107	(23)
Early reentry	50	7	6	63	(14)
Failure to vacate	51	2	3	56	(12)
Unintentional discharge	43	3	7	53	(11)
Too many TRFs for space	40	6	2	48	(10)
Failure to notify others	36	5	6	47	(10)
Sprayed in face or at close range	28	8	1	37	(8)
Inadequate airing out of treated space	27	2	3	32	(7)
Explosion	13	4	2	19	(4)
Using fogger as spot spray	10	4	2	16	(3)
Emergency response	6	2	0	8	(2)
Other	5	0	1	6	(1)
Unknown	42	4	5	51	(11)
Type of signs and symptoms experienced‡‡					
Respiratory (e.g., cough, respiratory tract irritation, dyspnea, and wheezing)	281	32	45	358	(77)
Gastrointestinal (e.g., nausea, vomiting, and abdominal pain)	163	13	37	213	(46)
Neurological (e.g., headache, dizziness, diaphoresis, weakness, and paresthesias)	154	16	8	178	(38)
Ocular (e.g., pain, irritation, inflammation, and lacrimation)	61	9	17	87	(19)
Dermatologic (e.g., skin irritation/pain, erythema, and rash)	67	5	3	75	(16)
Cardiovascular (e.g., chest pain, tachycardia, and hypertension)	45	3	0	48	(10)

* SENSOR = Sentinel Event Notification System for Occupational Risk (SENSOR)-Pesticides program; CDPR = California Department of Pesticide Regulation; NYCPCC = New York City Poison Control Center.

† California, Florida, Louisiana, Michigan, New York, Oregon, Texas, and Washington.

‡ Low-severity illnesses or injuries consist of illnesses and injuries that generally resolve without treatment and where minimal time (<3 days) is lost from work. Such cases typically manifest as eye, skin, and/or upper respiratory irritation. Moderate severity illnesses and injuries consist of non-life-threatening health effects that are generally systemic and require medical treatment. No residual disability is detected, and time lost from work is <6 days. High-severity illnesses and injuries consist of life-threatening health effects that usually require hospitalization, involve substantial time lost from work (>5 days), and can result in permanent impairment or disability. Deaths are fatalities resulting from exposure to one or more pesticides.

§ Cases of TRF-related illness or injury were classified as definite, probable, possible, or suspicious. Additional information available at http://www.cdc.gov/niosh/topics/pesticides/pdis/casedef2003_revapr2005.pdf.

** The Environmental Protection Agency classifies pesticide products into one of four toxicity categories based on established criteria (40 CFR part 156). Pesticides with the greatest toxicity are in category I, and those with the least are in category IV.

†† Each case might have more than one factor contributing to exposure.

‡‡ Many patients reported signs and symptoms in more than one organ system.

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Table 3

TABLE 3. Ten most common active ingredients in total release fogger (TRF) products* associated with illness or injury, by number of associated cases — eight states,† 2001–2006

Active ingredient (PC§ code)	Chemical class	No. of cases
Pyrethrins (069001)	Pyrethrin	182
Cypermethrin (109702)	Pyrethroid	122
Permethrin (109701)	Pyrethroid	95
Tetramethrin (069003)	Pyrethroid	75
Methoprene (105401)/ S-methoprene (105402)	Other	50
Fenvalerate (109301)	Pyrethroid	30
Tralomethrin (121501)	Pyrethroid	24
D-trans-allethrin (004003)	Pyrethroid	19
Phenothrin (069005)	Pyrethroid	18
Chlorpyrifos (059191)	Organophosphorus compound	15

SOURCES: Sentinel Event Notification System for Occupational Risk (SENSOR)-Pesticides program, California Department of Pesticide Regulation, and New York City Poison Control Center.

* Many TRF products contain more than one active ingredient.

† California, Florida, Louisiana, Michigan, New York, Oregon, Texas, and Washington.

§ Pesticide chemical; active ingredient code assigned by the Environmental Protection Agency.

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